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ABSTRACT

Recent developments in radio technology are reflected in increases in the number of stations available to listeners in more communities, improvements in audio technology, increased use of satellite interconnection, and extensive automation; however, too little of the impact of these continuing changes has been felt by radio management and academics in broadcasting. By 1990, it is estimated that 10,870 radio stations will be on the air in the United States, roughly two-thirds in FM service. The many improvements in AM stereo are mainly the result of standards advanced by the National Radio Systems Committee involving transmission preemphasis, receiver deemphasis, ten kilohertz bandwidth, and the "five year sunset." A potentially important development in FM technology is a system for extending FM stereo transmission. Improvements in program and production technology involve the increasing use of cellular telephones, satellite interconnection, and digital audio. While both the number of computers in radio and their sophistication can be expected to grow, there are several important constraints on that growth, such as the relative shortage of computer literacy skills among radio professionals. Graduate programs in radio should include instruction in the skills of systems analysis and the principles of both audio and radio technology and telecommunications. (JD)

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New Technology in Radio:

A Macro- and Micro- View

by

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The technology of radio continues to evolve - providing more listeners more stations broadcasting an ever wider variety of material in more communities and with higher audio quality. The recent pattern of this evolution has involved an increase in number of stations, improvements in audio technology, increased use of satellite interconnection and extensive automation.

More Radio Stations

By 1990 it is estimated that 10,870 radio stations will be on the air in the U. S. (Abel, 1986). This represents an increase of about 1500 stations, roughly two-thirds in FM service.

The greater number of FM stations are the result of F. C. C. Docket 80-90 which authorizes additional stations in designated communities by reducing the minimum geographic separation of stations operating on the same channel (often referred to as drop-ins). The Commission is currently making awards against allocations from this docket on a market by market basis.

About 500 AM radio stations will result from an increase in the frequencies reserved for the Standard (AM) Broadcast Band (new upper limit - 1705 kilohertz; old limit - 1605 kilohertz). To date this expansion has been endorsed

in the necessary world and regional forums. It is anticipated that implementing instructions will come from the F.C.C. in 1990.

In addition to new stations, upgrades in the quality of currently authorized services are underway. One upgrade extends the authorized operating hours of daytimers - AM stations previously allowed to operate from shortly before sunrise to just after sunset.

Extra hours for daytimers have resulted from agreements negotiated with Canada, the Bahamas and Mexico for U. S. stations to operate at night on frequencies of clear channel allocations to these countries. In the past the U. S. daytimers were able to operate on these frequencies only during daytime. With the recent signing of the agreement with Mexico many daytimers have been able to extend their hours of operation two hours after sunset. Additional stations on foreign clear channel frequencies (Canadian frequencies - 540, 690, 740,860, 990, 1010 and 1580 kilohertz; Mexican - 540, 730, 800, 900, 1050 and 1220 kilohertz; Bahamian - 1540 kilohertz) may broadcast at night at power levels recently authorized by the F. C. C. (N.A.B. Legal Department, 1986).

Improvements

AM Stereo. In 1982 the F. C. C. announced its controversial "marketplace" decision on AM stereo. In the

decision the Commissioners avoided naming a single standard for AM stereo broadcast and reception. In 1982 five different systems were competing to be named the standard. The F. C. C. decision held that marketplace competition should decide among those systems which had obtained type acceptance.

Today two of the five systems survive - the Kahn single sideband system and the Motorola C-Quam system. Of the two C-Quam seems to be ahead on two counts: number of receivers being manufactured which can receive C-Quam and number of radio stations broadcasting C-Quam.

Only three off-shore manufacturers of AM receivers - Sony, Sanyo and Sansui - are making models which can receive both systems. Nearly all other AM stereo receiving equipment receive C-Quam stereo only. Among the manufacturers of C-Quam-only AM receivers is the influential Delco which this year is supplying AM stereo radios as original equipment in GMC cars.

As for AM stations broadcasting in stereo, at the end of September 1986 85 were employing the Kahn stereo system; 335 stations, the Motorola C-Quam system ("AM stereo," 1986, p. 71).

AM Improvement

With the active encouragement of the F. C. C. the National Association of Broadcasters (NAB) and the

Electronic Industries Association (EIA) have formed the National Radio Systems Committee (NRSC). The NRSC is promoting voluntary national standards for improved AM service. The four standards advanced by the NRSC (1986) included:

1. Transmission preemphasis by AM radio stations.
2. Complimentary deemphasis in AM radio receivers.
3. Ten kilohertz AM transmission bandwidth.
4. Five year sunset.

Transmission preemphasis. Preemphasis is the boosting of high audio frequencies prior to modulation and transmission by an AM radio station. The recommended preemphasis curve is a "single zero curve with a break frequency at 2122 hertz." FM transmission involves a similar curve under current practice. The new AM preemphasis standard requires less preemphasis than many AM stations already use and was selected to minimize interference in adjacent channels from stations which are using too much preemphasis.

Receiver deemphasis. Deemphasis in AM receivers is a complimentary attentuation (reduction in amplitude) of high audio frequencies. AM receiver deemphasis is not now standard in receiver design. Most contemporary AM radio receiver designs are for narrowband reception, tuning a window of frequencies only five kilohertz or less in width.

By designing AM receivers with this narrow tuning window, engineers have been avoiding the unpleasant effects of adjacent channel interference - the consequence, as noted above, of the absence of preemphasis standards in current AM practice. AM receivers of narrowband design arbitrarily limit the range of audio frequencies which can be reproduced from an AM station signal. The goal of the NRSC standard is to make available to the public radio receivers with wideband tuning windows, able to reproduce a clean preemphasized signal.

Ten kilohertz bandwidth. This voluntary standard will require AM radio stations to attenuate audio frequencies that are ten kilohertz higher than the lowest audio frequency they will modulate and broadcast. Attenuation of audio frequencies above the ten kilohertz limit must be implemented before the signal reaches the station transmitter and antenna.

Five year sunset. Parties to the NRSC voluntary standards for AM improvement must implement the standards within five years.

Experimental antennas. Every beginning broadcasting student learns that antenna gain is an important determinant of coverage area for FM and television stations. Antenna gain is the result when antenna design permits electromagnetic waves directed toward the atmosphere and away from residences to be redirected toward the communities

served by the station. The power of an FM or television stations is - in practice - reported as Effective Radiated Power (ERP), the product of power fed into the antenna from the transmitter and antenna gain. Thus a fifty kilowatt transmitter feeding an antenna with antenna gain of 1.2 results in ERP of 60,000 watts.

Until now AM stations have had to be satisfied with antennas designed with gains of 1.0. With the addition of AM stereo, station engineers have reported some reduction in the coverage areas of their stations. As a consequence, there has been great interest in new AM antenna designs which promise gains greater than 1.0.

A number of cooperative experiments are aimed at developing new AM antenna designs. One such effort involves the F. C. C., NAB and Susquehanna Broadcasting; they will be trying experimental antenna designs in Virginia - designs utilizing top-loading devices. Top-loading involves steel structures at the top of the antenna pylon which reflect emissions away from the atmosphere and toward the horizon.

FMX

A potentially important development in FM technology is FMX, the CBS tradename for a system for extending FM stereo transmission. The system to date has been a co-venture of the CBS Technology Center and the NAB. CBS has recently announced the closing of its Technology Center, and an

additional partner is being sought for the FMX project ("Passing baton," 1986, p. 7).

FMX responds to a frustration of FM broadcasters - that full stereo service does not extend to the limit of the monaural signal of an FM station. FMX adds an additional signal to the two already broadcast for conventional FM stereo. In stereo transmissions the compatible or monaural signal [L+R] is a composite of the left and right audio channels from the audio production equipment of the station. A second signal - L-R or left minus right - is broadcast on a subcarrier. The contemporary FM stereo receiver feeds the right and left loudspeakers of the home audio system by reassembling right and left audio channels in this fashion:

[L+R] + [L-R] = 2L - left channel

[L+R] - [L-R] = 2R - right channel.

The problem for FM stereo coverage comes from the fact that a clear L-R subcarrier does not reach as far or with as much usable power as does the L+R signal of the center frequency of the FM channel.

The FMX system adds a second L-R signal to the one already broadcast. This additional signal is compressed and 90 degrees out of phase from the main L+R signal and at 38 kilohertz from the center frequency of the channel.

In the FMX receiver the second L-R signal is expanded, synchronized and combined with the first L-R signal, resulting in a combined L-R signal that will reach as far as

the main L+R signal. Advocates of the FMX system claim that stereo quality is improved throughout the coverage area of the FMX equipped station.

The FMX system requires a specially equipped stereo receiver for receiving and decoding the second L-R signal but does not interfere with stereo reception of conventional FM receivers (CBS Technology Center, 1986).

Program and Production Technology

Cellular Telephones

According to a recent survey conducted by the NAB (see Abel) nearly half of radio stations in the top twenty-five markets use cellular telephones in news and traffic reporting as well as for broadcasts from other remote sites. The performance of cellular telephones is considerably superior to the older mobile radiotelephones still in use at many other stations, since cellular telephone technology offers more channels and more reliability throughout the area served by the cellular system.

Satellite Interconnection

The same NAB survey reported that more than 85 percent of radio stations now have at least one satellite downlink. About half of stations have more than one satellite receiving dish, and about forty percent anticipate adding dishes in the coming year.

Network interconnection is only one of the functions provided by satellite interconnection. News services, syndicated programs, ad hoc networks and music services all arrive at the stations by satellite.

At the moment more than 55 audio services are carried by satellite, seventeen audio and pay radio services to cable systems, others to over-the-air radio stations. Of this number twenty represent networks, and sixteen are digital audio services. A number of these services are radio superstations, stations whose signal is extended by cable and satellite to include audiences within many markets. Among the stations achieving the distinctive rank of superstation are KKGO, WQXR, and WFMT. According to the NAB, one third of all radio stations are carried by at least one cable system.

Roughly one in every six radio stations today employs a satellite delivered program service. Some of the better known of these services are the Transtar Networks and the Satellite Music Channel. These are not networks in the conventional sense, since they do not program news, and they do not sell time. They do not have conventional affiliation agreements with their stations. But they do return an important feature of the Golden Age of Radio - the national radio programmer.

One of the factors contributing to the growth of satellite program services has been the relatively low cost

of satellite circuits. The low cost is not likely to continue as competition for available satellite audio channels increases. At the moment available program services provide only a single feed to the satellite. This means that the music climbing up to a satellite from Pennsylvania at 6 a.m. is coming down in Peoria at 5 a.m., in Santa Fe at 4 a.m., and in Portland at 3 a.m. As a result, the program services are not dayparted: that is, they are not programmed so that music closely matches time of day or daily routine. Many of these stations using satellite program services are also automated.

Digital Audio

The quality of sound heard on the radio has improved dramatically with the introduction of digital audio devices. Digital audio is contrasted with analog, the traditional form of audio storage and production in radio. Digital audio breaks the analog sound as it enters the audio processing system into a series of discrete steps, each step corresponding with one narrowly designated band of audio frequencies. In the standard compact disk, there are over 44 thousand of these discrete steps into which the sound can be decomposed. Each of these steps is handled by the digital processing system as though it is an on-off switch. If a given switch or step is off or not present then the reproducer in the system does not make the sound in

question. If the digital switch is on, then this component is added to the reproduced sound. The quality of a digital signal is dependent on the number of these discrete steps or switches into which the analog sound is divided.

Digital audio devices offer a number of advantages to the radio station. In the first place digital audio systems have less distortion - less difference between the sound as reproduced and the sound as it struck the microphone. Second, digital audio has a more favorable signal-to-noise ratio - less background noise and surface noise. Third, digital sound is easier to store and transmit without adding noise to the system.

Already almost a third of FM stations with Class C licenses (these are the most powerful FM stations) are equipped with compact disc (CD) reproduction equipment. Many of the professional quality CD players are controlled by microprocessors which permit various cuts of the CD to be played back in any stipulated order. In addition, players may be programmed to skip verses with objectionable lyrics or to shorten songs that are too long for the station format. Some professional CD players are multiple disk machines, capable of storing and playing in any order up to one hundred CDs. This means that more than sixty hours of continuous music may originate from a single player.

The other principal form of digital audio storage is the new Sony digital audio cassette system. In this system

analog sound is broken into more than 60 thousand steps or switches, fifty percent more than the standard compact disk. The digitized sound is stored on videocassettes in a very compact form, permitting ten hours of music to be recorded on a single videocassette. This new Sony system is ideally suited to broadcast program automation. Since these Sony cassettes are magnetically recorded, they can be assembled and copied in small quantities and rerecorded as often as required. With three of these units a radio automation system can provide more than thirty hours walkaway time (time between necessary programming activity by the operator of the system). A system of this sort is already on the market from Systemation of Decatur, Illinois with programming from TM Productions.

Computers

Half of all radio stations, more than two thirds of the largest FM stations, are equipped with general purpose computers. Two thirds of these computers are equipped with modems, devices that allow them to transfer data over telephone lines. The most popular of these computers are the IBM and IBM compatible personal and professional computers.

They are used for a wide variety of functions, the most common being traffic and billing, accounting, and other business applications. Some computers are used to control

and monitor transmitter and antenna performance. Still others analyze ratings and other research information, to write commercial copy, to make graphics for sales presentations, to manage station promotion budgets, to support the activities of the news department. There are even a number of computer software packages which automatically select music from the station library to be played on the air. Station security, telephone usage and power consumption may also be managed by computer.

While both the number of computers in radio and their sophistication can be expected to grow there are several important constraints on that growth that should be noted. One is the relative shortage of computer literacy and skills among radio professionals. At this point in radio's development computer skills are uncommon enough that workers manifesting such skills are likely to be labelled "computer persons" and continually assigned to such responsibilities even though the breadth or depth of their talents may indicate promise in other areas as well.

The second important constraint upon the computerization of the radio industry is the relatively high cost of computers and software when they have been configured to the specialized needs of radio. Examples are several software sets which consist of a single floppy disk for an Apple or IBM computer with fewer than 100 pages of documentation but prices in the range of $ 1,000 to $ 5,000.

Many software suppliers also provide hardware with the suggestion that the hardware they provide is somehow better than comparable hardware purchased from businesses offering discount bargains.

Conclusion

Radio is not at a level plateau in its technological evolution. A part of the rapid change in radio today is due to its increased profitability, reflected in double digit pre-tax profit margins and increased values for stations at sale. From 1955 to 1959 the average radio station sale approved by the F. C. C. amounted to just under 125 thousand dollars. During the period 1980 - 1985 the average sale was well over one million dollars (Fletcher, 1986). This prosperity has kept the industry in technological foment.

Too little of the impact of this continuing evolution has been felt by the management of radio or by academics in broadcasting. There is still the illusion that a successful radio worker can arrive at the industry with little or no specialized training, with few concepts or skills to cope with needed change.

To some extent this illusion is nurtured by the electronics industry which plays down the complexity and sophistication of its products in the interests of selling unneeded hardware to the ignorant and ill-prepared. Within academia we continue to offer graduate degrees devoid of

instruction in the skills of systems analysis, principles of audio and radio technology and telecommunications.

In college radio stations there has been too much emphasis upon fun and self-expression at the expense of professionalism.

If, as college teachers and researchers, we are to affect this regrettable state of affairs we must begin by becoming more proficient at technology.

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